The value of investigator-led research to the growth of Ireland’s Innovation Economy

A policy analysis from Trinity College Dublin highlighting the need to restore balance to the current system of research-funding in Ireland
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Dear Tanáiste and Minister for Enterprise, Trade and Employment, Leo Varadkar, T.D. & Minister for Further and Higher Education, Research, Innovation and Science, Simon Harris, T.D.

Data published by the European Commission in 2019 show a strong link between the funding of investigator-led research and innovation outputs. It shows that European Research Council (ERC) funding, which is focused on basic investigator-led research, is a stronger contributor to innovation outputs (invention disclosures, patents, licenses and company formation) than the EU’s funding programmes focused on applied research.

Using data on innovation outputs available to us in Trinity College Dublin, we tested the extent to which this is also true in Ireland. If it is true in Ireland then it is of critical importance for policy-making in this country that we restore the balance between investigator-led (basic) research and applied industry-co-funded research.

The key results are as follows:

1. A majority of innovation outputs come from investigator-led (basic) research, where research grants are held independently by individual Principal Investigators (PIs).

2. While research funding to projects with specific industry-linked metrics results in strong proportionate performance in delivering licences and patents, it is investigator-led research without constraints that delivers to a greater extent by creating more spinout companies, with associated inward Venture-Capital investment, and associated job creation.

3. Furthermore, regarding success in drawdown of European research funds, over two-thirds is by PIs who hold (or previously held) investigator-led basic research grants.

4. Using data from the Department of Public Expenditure Review 2019 Analysis of SFI Research Grants (2013-2017), it is clear that SFI’s co-funding of projects with industry is successful in generating licences and patents, but investment in basic investigator-led research translates into high-value spin-out companies at a far greater rate than any other kind of research funding.

5. Between 2009 and 2019 campus companies founded on the basis of investigator-led research in Trinity raised €80m in funding (Seed and A rounds). Investigator-led independent research is the mainstay of a knowledge economy and funding for it needs to be re-instituted as a matter of urgency.

Our findings show that different funding streams of investigator-led versus applied research should be targeted to achieve different but complementary outcomes in the research and innovation ecosystem – we cannot and should not rely on industry-sponsored applied research alone. The reality is that both are necessary together to achieve a functioning and effective research pipeline. Public funding of investigator-led research should be reinstituted at a level sufficient to generate a sound foundation for the research ecosystem as a whole.

Therefore it is not just the relatively small overall (0.96% vs 1.31% EU28 average) budget that is an issue, but the distribution of the budget over the last decade which exacerbated...
the challenges for the balance of Ireland’s research ecosystem. Decisions taken to focus scarce public resources on applied research\(^1\) has resulted in increased levels of industry collaboration and co-funding, which is positive, but it has come at a cost of the relative decline in the strength of the knowledge economy. Taking Trinity data as an example — a relative decline in citations is evident over the period and PhD student numbers have declined by a third (32%) since 2011. In essence, the result of the current policy approach is that Ireland is rapidly losing intellectual capital and the research pipeline cultivated by programmes such as the Programme for Research in Third Level Institutions (PRTLI) in the decade prior to the economic crisis is being steadily undermined.

The risks inherent in this are a negative systemic effect on the innovation economy and associated job-creation and an erosion of Ireland’s attractiveness as a base for knowledge, research and innovation.

The recent creation of a new Government Department for Further and Higher Education, Research, Innovation and Science brings together all the critical and interdependent policy areas of higher education and research for the first time. As successors to a number of key policies are being finalised (Innovation 2020, the new Enterprise Ireland and IDA Strategies are under development), there is now an opportunity to make decisions which will support a successful research ecosystem and secure a knowledge-driven society and economic growth into the future.

In that context, the following approach to policy development would be a significant step in the right direction:

1. Additional funding allocated for the research ecosystem should be invested in investigator-led research to support the regeneration of the research pipeline.
2. A 2:1 ratio should be introduced for disbursement of funding between investigator-led and collaborative industry research.
3. The promised successor to the Programme for Research in Third Level Institutions should by brought forward, and it should include policy instruments to ensure a coordinated capital and recurrent research funding environment.

A final point: the COVID-19 crisis has shown the critical contribution of scientific research. The progress being made in understanding the virus and its impact is rooted in investigator-led independent research, including research performed here in Ireland. Industry comes in to supply the market solutions. That is how innovation works, and without funding the education/research system to create the talent to drive basic research in Ireland we will lose the ability to participate in the global innovation economy. It is critical that we act now to prevent this.

The next iteration of Irish government policy in higher education and research will be instrumental in responding to this challenge and I urge you to institute a consultative process to create this policy and allow a plurality of voices to participate — that will generate the best outcome. As Ireland’s leading research University, Trinity College Dublin looks forward to active engagement with the Government and other key stakeholders to contribute to this work.

Yours sincerely,

Patrick Prendergast, PhD, ScD, FREng
PROVOST

Introduction

We are now at a critical juncture for the future of research and innovation in Ireland. A new Government has taken office, a new Department of Further and Higher Education, Research, Innovation and Science has been created, and several new governmental strategies are under development (viz. successors to Innovation 2020: EI strategy, IDA strategy, SFI strategy).

The creation of the new Government brings together the two critical and interdependent policy areas of higher education and research for the first time. We in Ireland have an unrivalled opportunity to drive an alignment of policy. For the first time Ireland has a realistic opportunity to create the most talented workforce in the world. The establishment of the new Department is an explicit recognition in itself of the intrinsic value of research at the heart of a successful higher education system, and as a driver of economic and social development.

It comes at a time when the critical contribution and relevance of scientific research has had heightened visibility as a result of the global research response - across many disciplines - to the COVID-19 crisis. The progress being made in understanding the virus and its impact is rooted in investigator-led research, conducted in Ireland and across the world. In a similar vein, looking at other current global challenges such as climate change or the threat to democracy in many parts of the world, the value of investigator-led independent research activity, across all spheres, is beyond question. However, there is evidence that investigator-led research is also successful at generating high-value innovation outputs, to a greater extent than industry-linked research.

Given the above, it is timely to reflect on how that funding is directed, i.e. the best balance of the funding mix between investigator-led and applied industry-linked research.

The purpose of this report is to make a contribution to such a process of reflection. Using data specific to Trinity, we examine the extent to which the funding of the individual PIs (Principal Investigators) who carry out investigator-led research - unrelated to any specific industry need at a given time – is critical not only to the advance of knowledge, but also to the development of the innovation economy and to the generation of innovation outputs, including high-value spin-out companies which create jobs and support economic development. It offers commentary and perspective against the backdrop of current research funding policy in Ireland and the approach to funding distribution adopted in recent years and highlights lessons for the critical policy and funding decisions of the coming period.

Trinity has had a successful track record in delivery of key innovation outputs. In the last 30 years, Trinity campus companies have created €1.3bn in exports, raised €600m in venture funding, and enabled 3,500 jobs. Trinity is the largest proportionate contributor of High Performance Start Ups at a national level from the higher education sector. This level of success has been supported by funding from key national, European and global research programmes. Trinity has been awarded almost 30 percent of Horizon 2020 funding coming into Ireland annually and 50 percent of ERC grant funding. Approximately 25% of total national SFI funding has been awarded to Trinity, and three SFI research centres — ADAPT, AMBER and CONNECT — are headquartered in Trinity.
Using unpublished data available only to us (i.e. specific to Trinity data accumulated over the past decade), this report tests the extent to which the funding of the individual PIs (Principal Investigators) who carry out investigator-led research is critical to the development of the innovation economy.

Later sections of the report are as follows:

Section 2 examines the current policy environment put in place by the Government and its agencies. We analyse the evolution of funding streams since 2006 and its impact on the research & innovation ecosystem. The interdependence between the funding of investigator-led and applied research is discussed and illustrated by a case-study which describes outcomes from investigator-led research in advanced materials.

In Section 3 we present data comparing key innovation outputs generated by Trinity-based PIs performing investigator-led and applied research. We use data from the Department of Public Expenditure Review 2019 Analysis of SFI Research Grants (2013-2017) to interpret the relative impact of different funding approaches in the delivery of innovation outputs driving the innovation economy.

Section 4 has a specific focus on the development of high-performance spin-out companies (HPSUs) in Trinity in the last ten years. It also charts their relative success in raising risk capital and developing into sustainable, scalable companies which generate employment.

Section 5, in conclusion, reflects on the data presented and the lessons to be drawn for policy making on public funding of research and innovation in Ireland.
Public investment in research in Ireland and comparator countries

2.1 Quantum of public funding of R&D – international comparisons

It is worth recalling that public funding in R&D in Ireland has fallen from a peak in 2008 of €930m to €751m in 2018. In terms of public investment in research, GBARD (Government Budget Allocations for Research and Development) at 0.32% of GNP is one of the lowest of all OECD countries. In addition, the Irish government has allocated far less of its overall budget to R&D (0.96%) compared to an EU28 average of 1.31%. This means that Ireland is far behind its competitors in terms of the quantum of public funding of research.

Ireland’s Innovation 2020 Strategy aimed to grow the national investment in research to 2.5% of GNP by 2020. However, it is estimated that to even meet the OECD average of GBARD at 0.51% of GNP, the exchequer would need to invest an additional €450m per year in addition to the €751m currently allocated. For Ireland’s GBARD to reach the EU average of 1.31% of total government expenditure the exchequer would need to invest an additional €273m per year in addition to the €751m currently allocated.

2.2 Distribution policy for public funds for R&D

In addition to the question of overall resources, how funding is distributed is an important factor in driving innovation.

Taking SFI as an example at a national level, and looking at the funding pattern since 2013, SFI has approved approx. €840m to Research Centres (including Phase 2) along with approx. €46m for Research Centre Spokes and approx. €3.6m Research Centre supplement totalling an estimated €890m. In the same time frame, SFI has approved funding of €226m for its Principal Investigator Programmes (PI) and €43m for CDAs (Career Development Awards) totalling €269m.

Even if SIRG (Starting Investigator) funding is included at €32m along with an anticipated €30m for Frontiers for the Future (FFF) (which is to replace the PI and CDA funding) the grand total is €331m from 2013-2019 which is just over a third of that committed to Research Centres at approx. €890m in the same time frame. Fig. 1 overleaf shows the shift in SFI’s commitments over time – a move away from funding independent research led by individual investigators (PI, CDA, SIRG) while maintaining and growing the investment in Centres.

Note: Five-year blocks have been taken over a fifteen-year period. Up to 2012 “Centres” consisted of CSETs and SRCs. From 2013 onwards “Centres” consists of Research Centres (Phase 1&2), RC Spokes and RC Supplements.
1. Funding approved per call

<table>
<thead>
<tr>
<th>Year of call</th>
<th>Centres + Spokes</th>
<th>IvP / CDA / SIRG</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 — 2010</td>
<td>€600,000,000</td>
<td>€200,000,000</td>
</tr>
<tr>
<td>2011 — 2015</td>
<td>€500,000,000</td>
<td>€300,000,000</td>
</tr>
<tr>
<td>2016 — 2020</td>
<td>€400,000,000</td>
<td>€400,000,000</td>
</tr>
</tbody>
</table>

Fig.1: Distribution of SFI funding in the 2006 to 2020 period showing a switch away from a balanced multi-stream approach (2006-2010) towards a model focused on the SFI Centres.

2.3 Interdependence within the research ecosystem

As the situation above illustrates, funding streams have been evolving since 2006. There has been increased focus on funding industry collaborations and large-centre oriented activity, while parallel programme funding streams for investigator-led research are 25% of what they were a decade ago. It is recognised that SFI Centres provide a mix of fundamental and applied research. Often it is the world class fundamental research carried out by the PIs that first attracts industry to participate in the Centres. Indeed the investigator cohort which comprise the Centres are often the same investigators who through individual PI funding have developed breakthroughs that result in important innovation outputs. Therefore the long term sustainability and success of the SFI Centres is also reliant on a well funded investigator-led research base.

This interdependence is illustrated by the case-study in Fig. 2 overleaf, which describes outcomes from investigator-led research in advanced materials carried out in Trinity and in the Trinity-based SFI Centre AMBER.
2. Interdependence within the research ecosystem

### 2016

<table>
<thead>
<tr>
<th>OUTCOMES</th>
<th>FOR RESEARCH – Further funding supporting further discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOR INDUSTRY – Global commercial success</td>
<td>In 2016 Prof. Coleman secured a European Research Council (ERC) Advanced Grant, FUTURE-PRINT, worth €2.2 m, to use liquid exfoliated nanosheets to produce printed electronic devices. The research underway thanks to this funding in turn opens the path for industry to cheaply print electronic devices from interactive smart food and drug labels to next-generation banknote security and e-passports.</td>
</tr>
<tr>
<td>Thomas Swan &amp; Co. Ltd has launched 14 new products directly as a result of the research discovery including Elicarb® Graphene Powder and Elicarb® Graphene Dispersion</td>
<td></td>
</tr>
</tbody>
</table>

### 2014

<table>
<thead>
<tr>
<th>Further publications Licences New industrial collaborations</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFI Centre supported industry-academia collaboration</td>
</tr>
<tr>
<td>SFI Centre AMBER (headquartered at Trinity) then co-funded and supported an industry-academia collaboration between the research group and the English-based global chemical manufacturing company, Thomas Swan &amp; Co. Ltd. The collaboration focused on the translation of this work into a process for the industrial scale-up of graphene.</td>
</tr>
</tbody>
</table>

### 2008

<table>
<thead>
<tr>
<th>Publications and Citations Publicly-funded investigator-led research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research breakthrough in 2008 resulted in publications in Science and Nature family journals and significant citations (7 papers on nanosheet production cited a total of 5800 times)</td>
</tr>
<tr>
<td>Investigator-led research (Prof. Jonathan Coleman) in liquid phase exfoliation of layered crystals to produce 2D materials such as graphene and MoS2</td>
</tr>
</tbody>
</table>

Fig. 2 is a case-study tracking the outcomes over time of investigator-led research in advanced materials. It illustrates how discoveries arising from investigator-led research are at the root of global commercial success and make a critical contribution to the innovation economy, as well as adding to the sum of scientific knowledge. This would not have happened without the type of public investment in the original investigator-led research which is no longer in place in Ireland.

Without support for talented individuals (such as Prof Coleman in this case, Fig. 2) there would be no basis or foundations on which to build large scale SFI centres. And, in addition to keep the cycle of innovation going, this investment in individual Principal Investigators needs constant renewal.

The Programme for Research in Third Level Institutions (PRTLI) which began in 1998 had five successive funding cycles, the most recent of which (Cycle 5) was announced in 2010, with all funded projects and activities now complete. In addition to supporting the provision of top-class research infrastructure (buildings, laboratories and cutting-edge equipment), PRTLI saw significant investment in human capital development, through Structured PhD/Emergent Technology programmes across Ireland’s Higher Education Institutes (HEIs).

An independent evaluation of the impact of PRTLI funding commissioned by the HEA in 20113 (“Ten Years On: Confirming Impacts from Research Investment”) included the illustration in Fig. 3 below highlighting the importance of the PRTLI funding programme in feeding the rest of the innovation system.

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While Innovation 2020, the Government’s strategy for research and innovation, included an action to scope out and develop a successor to PRTLI to support new investment in research infrastructure and to increase the enrolment of PhD and research masters students, this has not yet been done. The introduction of the Frontiers for the Future Programme by SFI is a welcome step, however, as is the plan under the National Development Plan 2018–2027 for a successor programme to PRTLI.

3. The Support Model for Higher Education Research in Ireland

It shows the PRTLI providing a foundation for research performance through support and funding of a strategic approach to research. This then acts as the sustainable basis on which funding from exchequer sources such as SFI, IRC and the HRB supports specific types of research activities. These in turn feed the pipeline of commercialisation which, supported by Enterprise Ireland, ultimately realises the benefits of such research to create high value employment and wider economic impact. The implication is that without the solid foundational base provided by the PRTLI and support for investigator-led research, the rest of the system is compromised and lacks sustainability.

2.4 Negative impacts of current policies

Investigator-led research provides a track record for talented young researchers based in Ireland to compete internationally for ERC and other prestigious European funding (e.g. Horizon Europe etc.) and also to attract FDI. Investigator-led research also provides the pipeline of new research which ultimately forms the basis for the evolution of the SFI Research Centres, which must also respond over time to global trends and national objectives. Ireland is performing poorly in Europe for ERC grants at present. In 2019, only one ERC advanced award was made to a researcher based in an Irish HEI, while many more awards were made to Irish researchers based in universities in the UK and other European HEIs. This represents the threat that our best talent is leaving Ireland due to the funding environment. In addition, Ireland is not an attractive location for overseas talent due to the challenging funding environment – a fact further borne out by the limited success of SFI’s Research Professorship Programme.
It is worth noting that since 2011, when funding policy was recast to focus national resources towards SFI Centre-led activity, there have been successes in increased levels of industry collaboration and co-funding and increased licensing and commercialisation activity in the short term.

However, in the same period, there has been a relative decline in citations for Trinity, as observed in the Times Higher Education rankings data in Fig. 4.

![Fig. 4 The Rankings for Citations 2011–2020 — Trinity College Dublin](image)

In addition, PhD student numbers in Trinity have also declined by a third (32%) since 2011 (1,821 to 1,239 in 2018), see Figure 5 below.

![Fig. 5. No. of Research Fellows vs PGR Enrolments from 2012—2018](image)

Fig. 5. illustrates the decline in PhD students in Trinity since 2012 with a corresponding increase in the number of postdocs. This shows that the number of individuals receiving training in reducing whereas the number of postdocs on shorter contracts doing shorter-term industry work is increasing.
Looking at the breakdown of funded PhDs in Trinity between 2014 and 2018, Trinity has recorded a total of 1,158 studentships, of which a total of 282 were funded via SFI, a ratio of approximately 3:1.

The consequences of not rebalancing this research investment are real and severe. We can not sustain falling PhD numbers, reduced citations and a lack of funding for our PIs to gain a track record to compete for international funding. Importantly as we strive to rebalance the dependence of our economy on FDI we need to ensure we can grow new internationally competitive innovation businesses. An increase in individual PI funding is a requirement to achieve these outcomes.

03
Research origin of key innovation outputs—Trinity College Dublin

3.1 Overview – contribution of investigator-led research to innovation outputs

The data below on the generation of innovation outputs between 2014-2018 in Trinity College Dublin, including those produced in the SFI Centres headquartered in Trinity, (ADAPT, AMBER and CONNECT) presents an overall picture.

<table>
<thead>
<tr>
<th>Innovation Output</th>
<th>Independent Principal Investigator grants (i.e., Trinity College Dublin excluding SFI Centres)</th>
<th>SFI Centres Headquartered in Trinity</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>IDFs</td>
<td>226</td>
<td>73%</td>
<td>82</td>
</tr>
<tr>
<td>Patents</td>
<td>70</td>
<td>78%</td>
<td>20</td>
</tr>
<tr>
<td>Licences</td>
<td>46</td>
<td>66%</td>
<td>23</td>
</tr>
<tr>
<td>Spinouts</td>
<td>16</td>
<td>84%</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1: — Table showing that the greatest proportion of Innovation Outputs in Trinity arises from investigator-led independent research

The table above illustrates that funding to research with specific industry-linked metrics (i.e. SFI Centres) in strong proportionate performance in delivering licences and patents, investigator-led research is equally good in these metrics while additionally delivering to a higher degree in the creation of spinout companies. These spinout companies (or ‘start-ups’) are the seed-bed of an Innovation Economy like Ireland is trying to create.

4 The term IDF incorporates both IDFs (Invention Disclosure forms) and SDFs (Software Disclosure forms). IDF Data is taken from Trinity quarterly data submissions to Knowledge Transfer Ireland as part of the Technology Transfer Strengthening Initiative III (TTSI-III), using funding history as cited at time of reporting.
3.2 Trinity Innovation Outputs compared with National Innovation Outputs

The following data from the Department of Public Expenditure Review 2019 Analysis of SFI Research Grants (2013-2017) – the most recent publicly-available national analysis of this type – illustrates the return on investment of SFI funding in the generation of Licenses, Patents and Spin-Outs over a five-year period.

<table>
<thead>
<tr>
<th>SFI funded research: Innovation Outputs (all of Ireland)</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licensed Technology</td>
<td>28</td>
<td>19</td>
<td>19</td>
<td>45</td>
<td>27</td>
<td>138</td>
</tr>
<tr>
<td>Patents (Filed + Pending)</td>
<td>57</td>
<td>43</td>
<td>47</td>
<td>67</td>
<td>53</td>
<td>267</td>
</tr>
<tr>
<td>Spinouts</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Res Expenditure (‘000)</td>
<td>162</td>
<td>163</td>
<td>172</td>
<td>196</td>
<td>187</td>
<td>880</td>
</tr>
</tbody>
</table>

DEPR/SFI Innovation Outputs

Table 2: — Table showing the innovation outputs from SFI funded research, for all of Ireland from 2013 to 2017. The small number of spin-outs is clear – i.e. 18 over five years whereas investigator-led research in Trinity alone over a four year period was 18 (see Table 1)

It is worth noting that the data is broadly consistent with Trinity’s share of SFI funding at a national level (25%), except in the case of spinouts. This figure is disproportionately high because of Trinity’s relative success in an Irish context in winning Principal Investigator funding in Europe and from other international sources.

3.3 Trinity Innovation Outputs compared with the US Higher Education System

Data from Trinity (including the SFI Centres based at Trinity) illustrates a favourable comparison with the US higher-education system as follows:

<table>
<thead>
<tr>
<th>Ratios (Res Expenditure)</th>
<th>US ($)</th>
<th>Trinity (not including SFI Centres)</th>
<th>SFI Centres based at Trinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>IDF (per €10m)*</td>
<td>4.00</td>
<td>8.77</td>
<td>4.55</td>
</tr>
<tr>
<td>Pat App (per €10m)</td>
<td>2.50</td>
<td>1.59</td>
<td>3.03</td>
</tr>
<tr>
<td>Licence (per €10m)</td>
<td>1.10</td>
<td>1.44</td>
<td>1.56</td>
</tr>
<tr>
<td>Spin-out (per €100m)</td>
<td>1.00</td>
<td>4.08</td>
<td>2.04</td>
</tr>
</tbody>
</table>

Table 3 — Trinity and SFI at Trinity comparator w/US Universities using data norms accepted by AUTM (Association of University Technology Managers) for the US system.

Trinity and the SFI Centres it leads compare very well against the average University performance in the US, but independent research funded via PI grants is best of all in relation to spin-outs. Trinity’s performance on IDF creation is more than twice the US number and its performance for Spin-Out creation is four times the US average. This data underlines the inherent strengths of Ireland’s Higher Education and research system.

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5 Section 7 “Analysis of Activities and Outputs of SFI Grants for R&D” from the IGEES and the Department of Public Expenditure and Reform Spending Review 2019 report “Analysis of Science Foundation Ireland Research Grants”. The original source of the data is the SFI SEASAME Database. The report notes some limitations and challenges in analysing the data, including the self-reporting nature of the system and capturing the longer term (10 year) outputs and outcomes of grants. It notes that SEASAME is being continually refined by SFI, which means that inconsistencies in how data are collected over time can pose difficulties for analysis.
3.4 European Funding

We have noted above that Ireland’s overall performance in achieving ERC grants has been declining. Trinity-based researchers have received a total of 42 European Research Council (ERC) awards, worth €61.31m, since the programme was established. Of these 16 were secured by PIs attached to the SFI Research Centres headquartered in Trinity. Taking ERC and FP7/Horizon 2020 together since they were established and looking at the overall picture, approximately two-thirds have been awarded to PIs who hold (or previously held) investigator-led research basic research grants. Ireland’s ability to compete for international research funding is directly correlated with the funding we provide for individual PI research. This understanding is critical as we look to recruit and retain the best academic and research talent to Ireland.

04

Success of Spin-Outs – Origin and Funding

4.1 HPSUs, Active and Inactive Spinouts (2009-2019)

This section explores in more detail the data behind the origin of spin-out companies in Trinity in the last ten years and looks at performance in raising risk-capital in the same period. Data on spin-out companies generated in Trinity between 2009 and 2019 is set out below. HPSUs (High-Performing Start-Ups) are defined as businesses with the potential to develop an innovative product or service for sale on international markets and the potential to create 10 jobs and €1m in sales within 3 years of starting up.

![Bar chart showing the combined total of spin-out companies from Trinity, including those generated by research conducted in the SFI Centres headquartered in Trinity.](image)

**Fig. 6:** This bar chart shows the combined total of spin-out companies from Trinity, including those generated by research conducted in the SFI Centres headquartered in Trinity. (Note: SFI Centre metrics do not include specific targets for spinouts)

6 HPSUs (High-Performing Start-Ups) are defined as businesses with the potential to develop an innovative product or service for sale on international markets and the potential to create 10 jobs and €1m in sales within 3 years of starting up.

Active - an active spin-out is still operating as normal as per the Company Registration Office.

Inactive - an inactive spin-out is one that is no longer in existence.
4.2 Funding raised

Taking the same ten-year period as the data above, the total amount of funding raised by spinouts (Seed and A rounds), including those generated in the SFI Centres headquartered in Trinity was €82m. Looking at the breakdown, it should be noted here again that SFI Centre metrics are not focused on spinouts.

<table>
<thead>
<tr>
<th>2009–2019</th>
<th>Trinity (investigator-led basic research)</th>
<th>SFI Centre at Trinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funds Raised (Seed + A rounds)</td>
<td>€80.08m</td>
<td>€1.98m</td>
</tr>
</tbody>
</table>

Table 4 — Total amount of funding raised by spinouts (Seed and A rounds), including those generated in the SFI Centres headquartered in Trinity

4.3 Strategic focus on HPSU creation

Since 2017, Trinity has had a strategic focus on producing high calibre companies from the University’s spinout pipeline i.e. not including the spinouts derived from SFI Centre support.

This effort is bearing fruit, with 12 HPSUs having been established between 2017-2020 - a greater number than in the previous 10 years combined. Great credit should be given to the support of Enterprise Ireland in these successes.

![Graph showing amount of funding approved (€) from 2010 to 2020](image)

**Fig. 7:** Trinity’s success in establishing HPSUs in recent years is a function of an increased strategic focus since 2017, which is evident from the bar-chart above. The figure for 2020 is indicative.

The current commercialisation pipeline at Trinity now contains 22 projects which have HPSU potential, and which have secured research funding of €14m. This should continue the trend of HPSU formations over the next three years.

In 2016 Trinity and UCD created and became Limited Partners in the University Bridge Fund attracting €60m of funding from Enterprise Ireland, the European Investment Fund, Allied Irish Bank and Bank of Ireland. This is the 4th largest Investment Fund of its type in Europe.

The strategic focus on HPSU creation, coupled with the new investment fund, has produced Trinity’s most successful period of research commercialisation.
The €12m in research and commercialisation funding which led directly to the creation of these companies was successfully awarded from a variety of funding agencies including Enterprise Ireland, SFI, EIT, EU H2020, HRB, Wellcome Trust, Cancer Ireland and Trinity (for IP protection). The sources of the research funding underpinning these spinouts is shown in Fig.8. These companies have created over 110 high-tech jobs and are continuously scaling with the help of Enterprise Ireland, The University Bridge Fund and other investors.

Fig. 8: Sources of funding underpinning the 12 Trinity spinouts created between 2017 and 2020.

Fig. 9: Overall, the €12m investment in these spinouts has generated €46m in equity and non-equity funding during this period.

05. Discussion and Conclusion

In this work we set out to investigate the origin of innovation outputs by looking at data specific to one institution: Trinity College Dublin. We found that different funding streams deliver different outputs and, while research funding to projects with specific industry-linked metrics results in strong proportionate performance in delivering licences and patents, investigator-led research without those constraints delivers better in the creation of IPR and spinout companies thereby stimulating the innovation economy.
We also illustrated the interdependence within the research ecosystem and underlined using a case-study that while it is recognised that the SFI Centres do provide a mix of fundamental and applied research, it also has to be recognised that the Centres themselves are supported by the investigator cohort who provide much of the unpredictable breakthroughs and underpinning research on which the Centres – and the country’s economic and societal resilience – are ultimately reliant. Failure to ‘feed’ the roots of the research ecosystem (i.e. investigator-led research) with adequate funding will lead to the failure of the research ecosystem in its entirety. We therefore advocate that independent investigator-led research funding be reinstituted as a significant proportion of total research funding.

Therefore, if Ireland is aiming for the development of an Innovation Economy with the associated benefits, including job-creation, this analysis supports a policy which would increase funding of investigator-led research relative to industry-led research within the overall research funding mix.

To put it another way, if funding continues to be concentrated in SFI Centres at the expense of investigator-led research, there will be adverse consequences for Ireland’s future as a knowledge-driven society, including direct economic impacts, such as a drop off in spin-out companies which are so crucial to job creation and a resilient, diversified tech economy.

In a wider international policy context, the conclusions presented in this report are not surprising. For example, the graph in Fig. 10 below plots Intellectual Property (IPR) applications for EU research programmes (x axis) against quantum of funding (y-axis). It shows funding from the European Research Council – which funds only basic investigator-led research – is a greater contributor to innovation outputs than all the thematic applied funding schemes except ICT, with ICT being only marginally better. The sections which follow analyse data from Trinity to test the extent to which this is also true in an Irish context.  

10. European Commission (Horizon Dashboard 2019)

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**Fig. 10:** Data from the European Commission (Horizon Dashboard 2019) shows the prominence in the wider funding mix of ERC grants for basic research and its pre-eminent role in generating intellectual property, including patents, copyrights, patents, trademarks and trade secrets.

It shows the extent to which funding from the European Research Council – which funds only basic investigator-led research – is a stronger contributor to innovation outputs than the EU’s funding programmes focused on applied research.

If the goals of Government policy are to achieve a balanced research ecosystem with:

- sustainable research excellence as a platform to secure a knowledge-driven society and economic growth into the future
- a strong cohort of Irish-based Principal Investigators and a sustainable pipeline for future talent attractive to industry
- success by Irish-based researchers in accessing European and international funding for basic research - including European Research Council (ERC) grants
- research fuelling a dynamic innovation economy, including High Potential Start-Ups capable of developing into sustainable, scalable companies which can generate employment

Then, the introduction of the following policy targets and measures would be a step in the right direction:

1. A ‘back to basics’ approach - additional funding secured for the research ecosystem should be invested in investigator led research to support the regeneration of the research pipeline.
2. A 2:1 ratio should be introduced for disbursement of funding between investigator-led and collaborative industry research
3. The promised successor to the Programme for Research in Third Level Institutions should include the following streams to feed and sustain the research pipeline:
   - Programme funding support for advanced investigators
   - Early career funding for Junior Principal Investigators
   - A ‘new blood’ funding scheme to support training of PhDs
   - Provision for infrastructural investment

Ireland through its innovative tax policy has attracted the world’s leading companies to Ireland. Our reputation for innovation and talent is now evolving the mandate of these businesses to be research and innovation active. Innovation is critical to sustaining and growing their presence in Ireland. This is underpinned by PI funding. Irish government policy in higher education and research will therefore be critical as the global goalposts shift and the future global position and relative prosperity of the country is in play. There is an opportunity now for Government policy to recognise this and to restore balance to the approach to public investment in research in Ireland.

Acknowledgements
This document has had input from staff in the Office of the Dean of Research and Trinity Research and innovation, as well as several senior academics within and staff of the Irish Universities Association.